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Geosynthetics — Guidelines for Installation of Geotextile Used in Subsurface Drainage Application

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Geosynthetics Sectional Committee, TXD 30

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Geosynthetics Sectional Committee had been approved by the Textile Division Council.

Control of water is critical to the performance of buildings, pavements, embankments, retaining walls and other structures. Drains are used to relieve the hydrostatic pressure against underground and retaining walls, slabs and underground tanks and to prevent loss of soil strength and stability in slopes, embankments and beneath pavements. In transportation applications, if the base course does not drain rapidly enough, stress from the traffic loadings is transferred to the sub-grade with little or no reduction, resulting in accelerated road failure. The removal of water shall be performed in a controlled fashion. Otherwise, severe erosion, piping, or settlement of soils may result in undermining adjacent structures. To accomplish this task the drainage system should fulfil two criteria:

a) Have maintained permeability by providing relatively unimpeded flow of water; and
b) Filtration of base soil by preventing the migration of soil fines into the drain.

These criteria can be met by using several layers of specially graded aggregates. This often proves to be extremely expensive requirement to meet. The same result can be achieved at a fraction of the cost by using selected geotextiles, which act as filters around the aggregate drainage system. The introduction of geotextile lined drainage systems has enhanced the technical benefits and economical application of blanket and trench drains under and adjacent to pavement structures. The excellent filtration and separation characteristics associated with geotextiles permits the use of a single layer of open graded aggregate base or trench aggregate enveloped in a geotextile.

The stability of the sub-grade soils depends on ground water table. Some clay soils can swell or shrink as their water content increases or decreases, respectively. Also, most soils are considerably weaker when they have high water contents or have not been drained prior to loading. This means that weather-related or seasonal fluctuations in groundwater levels can adversely affect permanent structures founded on undrained soils. Therefore, draining the saturated soils can increase their strength and stability. Lower the permeability of the sub-grade soils, the closer together the drainage layers/zones shall be to provide effective dewatering.

The traditional methods of sub-grade dewatering by digging a trench or providing a coarse aggregate drainage layer or a pipe system or use of fine sand as a filter are time consuming and costly and provide inconsistent properties. Geotextiles are being used in lieu of select grades of sand for effective dewatering to accept seepage and act as properly graded filter to prevent piping of sub-grade soil because they are less expensive, provide more consistent properties and are much easier to install. Geotextiles have been used in the drains of embankments where they are easily accessible if maintenance is required and where malfunction can be detected.

The excellent filtration and separation characteristics associated with filtration geotextiles permits the use of a single layer of an open graded base or trench aggregate enveloped in a geotextile. The thin filtration geotextile reduces the required excavation as well as the cost of the drained structural section. The increase in service life of flexible pavements by 25 percent and that of rigid pavements by 50 percent has been identified by use of an efficient functioning edge drain system using geotextile.

Filtration and separation fabrics are non-woven or woven polypropylene or polyester fabrics with specified strength characteristics used as permeable separators to restrain soil or other particles subjected to hydrodynamic forces while allowing the passage of fluids into or across a geotextile and to prevent inter-migration of adjacent soil layers of vastly different particle sizes and particle distributions. The primary geotextile characteristics influencing filter functions are opening size (as related to soil retention), flow capacity and clogging potential which are indirectly measured by the apparent opening size, permittivity and gradient ratio test. The geotextile shall also have the strength and durability to survive construction and long-term conditions for the design life of the drain. Additionally, construction methods have a critical influence on geotextile drain performance.

(*Continued to third cover*)

Indian Standard

GEOSYNTHETICS — GUIDELINES FOR INSTALLATION OF GEOTEXTILE USED IN SUBSURFACE DRAINAGE APPLICATION

1 SCOPE

This standard prescribes guidelines for installation of geotextile used in subsurface drainage application.

2 INSTALLATION OF GEOTEXTILE IN SUB-GRADE DEWATERING

2.1 Excavations shall be done according to project plans and in such a way so as to prevent large voids from occurring in the sides and bottom of the trench. The graded surface shall be smooth and free of debris. Clear and grade the installation area. Remove all sharp objects and large stones. Cut trees and shrubs flush with the sub-grade. Removal of topsoil and vegetation mat is not necessary, but is recommended where practical. Excessive soft spots or voids may be unsuitable for geosynthetic installation. The problem area may be enhanced by using a geosynthetic at the bottom of the excavation prior to backfilling.

2.1.2 *Deployment of the Geosynthetic*

2.1.2.1 Unroll the geosynthetic in the direction of construction traffic. Hold the geosynthetic in place with pins, staples, fill materials or rocks. Do not drag the geotextile on the ground or mishandle in any way. Loosely place the geotextile in the trench without wrinkles or folds, and with no void spaces between the geotextile and the ground surface so that the placement of the overlying material will not tear the geotextile. Successive sheets of geotextiles shall be overlapped a minimum of 300 mm, with the upstream sheet overlapping the downstream sheet.

2.1.2.2 In case of slopes, place the geotextile with the machine direction oriented up-down. Lap the upper sheets over the lower sheets. When the geotextile is placed on a slope steeper than 6V:1H, securely anchor the laps to the ground surface with pins or stakes as necessary to prevent the slippage and tearing of the geotextile. Start placement of fill material on the geotextile at the toe of the slope and proceed upwards.

2.1.2.3 On curves, the geosynthetic may be folded or cut to conform to the curves. The fold or overlap shall be in the direction of construction and held in place by pins, staples, or piles of fill or rock.

2.1.2.4 If geotextiles are placed under water or in areas where water will flow, the geotextile may be placed with the machine direction parallel to the direction of water flow. Overlap sheets such that upstream sheet is placed over the top of the downstream sheet. Adequately secure the geotextile to prevent slippage. As the geotextile is placed under water, place the backfill material on it to the required thickness. Do not place geotextile more than 15 m ahead of the specified cover material.

2.1.2.5 After placing the drainage aggregate in trenches equal to or greater than 300 mm wide, the geotextile shall be folded over the top of the backfill material in a manner to produce a minimum overlap of 300 mm. In trenches less than 300 mm but greater than 100 mm wide, the overlap shall be equal to the width of the trench. Where the trench is less than100 mm wide, the geotextile overlap shall be sewn or otherwise bonded.

2.1.2.6 When field sewn seams are required, sew field seams with polymeric thread consisting of polypropylene or polyester and as resistant to deterioration as the geotextile being sewn. Use a colour of thread that contrasts with the geotextile being sewn so that the stitches are exposed for inspection when the geotextile is placed. Seams shall meet the testing requirements given below:

a) Use two rows of lock type stitching, to make the seams. The two rows of stitching shall be 12 mm apart with a tolerance of ± 6 mm and not cross except for restitching.

b) The minimum seam allowance (the minimum distance from the edge of geotextile to the nearest stitching shall be:

Flat or Prayer Seam, Type SSa-1	40 mm
"J" Seam, Type SSn-1	25 mm
Butterfly – folded Seam, Type SSd-1	25 mm

c) Obtain the geotextile manufacturer's recommendation for the type of seam and stitch to be used. If the contractor does not obtain and provide this information, use a "J" seam with at least three stitches per 25 mm. The flat or prayer seam may be used for repair or damaged in-place geotextile.

2.1.2.7 In case the geotextile is damaged during installation, or drainage aggregate placement, a geotextile patch shall be placed over the damaged area extending beyond the damaged area a distance of 300 mm, or the specified seam overlap, whichever is greater.

2.1.2.8 Placement of drainage aggregate shall proceed immediately following placement of the geotextile. The geotextile shall be covered with a minimum of 300 mm of loosely placed aggregate prior to compaction. If a perforated collector pipe is to be installed in the trench, a bedding layer of drainage aggregate shall be placed below the pipe, with the remainder of the aggregate placed to a minimum required construction depth. The aggregate shall be compacted with vibratory equipment unless the trench is required for structural support.

2.1.2.9 The geotextile shall be laid at the proper elevation and alignment as shown on the construction drawings. The geotextile may be temporarily secured in place with ties, staples, pins, sand bags or backfill as required by fill properties, fill placement procedures or weather conditions.

3 INSTALLATION OF GEOTEXTILE IN ROADBASE DRAINAGE

3.1 New Construction

When constructing a new road with an open graded base course designed to provide blanket drainage also, a filtration geotextile shall be deployed prior to placement of the base course in the same manner as a separation geotextile. Commonly, the base course terminates along the road edges into deepened edge drains. These edge drains shall also be wrapped with the geotextile.

3.2 Retrofit

Excavations for retrofit edge drains shall be done in such a way so as to prevent large voids from occurring in the sides and bottom of the trench. The edge drain can be an aggregate trench drain with a collector pipe in the bottom.

3.3 Geocomposite Edge Drain

Alternately, a geocomposite edge drain can be used. The excavator, if properly equipped, shall lay a geocomposite drain into a narrow trench and backfill with sand between the drain and the exposed base course.

4 INSTALLATION OF GEOTEXTILE IN STRUCTURAL DRAINAGE

4.1 Excavation shall be done according to project plan and in such a way so as to prevent large voids from occurring in the sides and bottom of the trench.

4.2 Place a filtration geotextile on the excavated stable slope in back of the wall, then place 150 mm of permeable crushed rock 6 to 25 mm in size over the geotextile, and cover the rock with another layer of filtration geotextilre.

4.3 A prefabricated geocomposite drain may also be used in horizontal or vertical applications. In vertical application, install the drain over the waterproofed wall with the filter fabric side away from the wall surface. As additional drain sections are added, insure that there is positive fabric overlap. Overlap panels in the direction of water flow. If a drainpipe discharge system is used, place the bottom of the drain behind the geotextile-covered drain pipe and aggregate. Soil shall be placed and compacted adjacent to the drain.

4.4 In horizontal applications (for example plazaks), lay the initial drain section horizontally, filter fabric side up. Make sure that the drain properly attaches to an outflow drain and that additional drain sections properly overlap, insuring a continuous flow path. Place temporary ballast atop the drain until the permanent decking is placed.

5 PLACEMENT OF THE AGGREGATE

5.1 Prior to covering, the geosynthetic shall be inspected by a certified inspector or the Engineer to ensure that the geosynthetic has not been damaged during installation. Damaged geosynthetic shall be repaired immediately. Cover the damaged area with a geosynthetic patch which extends an amount equal to the required overlap beyond the damaged area.

5.2 The subbase or base shall be placed by end dumping onto the geosynthetic from the edge of the geosynthetic, or over previously placed subbase or base aggregate. A minimum fill soil thickness of 150 mm is required.

5.3 Any ruts occurring during construction shall be filled with additional subbase or base material, and compacted to the specified density.

5.4 Place, spread, and compact granular fill material in such a manner that minimizes the development of wrinkles in or movement of the geotextile.

5.5 Caution should be used when selecting compaction equipment. When thin lifts are used, vibratory compaction is not recommended until a minimum 30 cm compacted thickness is achieved. Use of such equipment may result in damage to the geosynthetic.

5.6 Replace at no additional cost to the Department any roll of geotextile damaged before, during, or after installation. Proper replacement consists of replacing the affected area and overlapping the geotextile one foot on all sides adjacent to the damaged area.

5.7 If placement of the backfill material causes damage to the geosynthetic, the damaged area shall be repaired as previously described above. The placement procedure shall then be modified to eliminate further damage from taking place.

6 PROTECTION OF GEOTEXTILE

6.1 Protect the geotextile at all times from ultraviolet (UV) rays, contamination by surface runoff and construction activities. Traffic or construction equipment shall not be permitted directly on the geotextile except as directed.

6.2 During installation, cover the geotextile with specified cover material as soon as possible. Do not leave in uncovered condition for more than five days, except when used with temporary, wrapfaced, mechanically stabilized earth walls and asphalt overlays.

6.3 Place the cover material on the geotextile in such a manner that the geotextile is not torn, punctured or shifted. Use a minimum 150 mm thick cover layer or twice the maximum aggregate size, whichever is thicker. Do not end-dump cover material directly on geotextiles other than riprap geotextile.

6.4 Limit the construction vehicles in size and mass so that the rutting in the initial layer above the geotextile is not more than 75 mm deep or half the layer thickness, whichever is lesser. Do not turn vehicles on the first layer.

7 OTHER FILTER CONSIDERATIONS

7.1 Ensure intimate contact between the soil and the geotextile during construction in order to prevent clogging or blinding of the geotextile. Voids between the soil and the geotextile can expose the geotextile to a slurry or muddy water mixture during seepage which promotes erosion of soil behind the geotextile and hence clogging of the geotextile.

NOTES

1 Very fine grained non-cohesive soils, such as rock flour, present a special problem, and design of drain installations in this type of soil should be based on tests with expected hydraulic conditions using the soil and geotextile.

2 As a general rule slit-film geotexiles are unacceptable for drainage applications. They generally have very low POA (percent open area) or permeability. The wide filament in many slit films is prone to move relative to the cross filaments during handling and thus change AOS and POA.

7.2 If there is reasonable expectation of an ochre formation in certain areas (an iron deposit usually a red or tan gelatinous mass associated with bacterial slimes) on the geotextile, discourage the use of geotextile because it becomes more prone to clog and once ochre clogging occurs, it is very difficult to impossible to remove as chemicals or acids used for ochre removal may damage geotextiles. Also, high pressure jetting through the perforated pipe is relatively ineffective on clogged geotextiles.

8 INSPECTION

8.1 The owner or owner's representative may randomly inspect geotextile before, during and after (using test pits) installation.

8.2 Any damaged or defective geotextile (that is frayed coating, separated junctions, separated layers, tears, etc) shall be repaired/replaced in accordance with **9**.

9 DAMAGE REPAIR

9.1 Repair damaged geosynthetic immediately. Clear the damaged area and an additional 90 cm around it of all fill material. Cover the cleared area with a piece of the geosynthetic. The patch should extend at least 90 cm beyond the perimeter of the damage. Replace the aggregate and compact to the specified density.

9.2 Repair or replace all torn, punctured or contaminated geotextiles during construction at no cost to the Agency. Repair by placing a patch of the specified geotextile over the affected area. Overlap the existing geotextile with the patch.

9.3 Where geotextile seams are required to be sewn, repair any damaged sheet by sewing unless otherwise indicated on the plans or special provisions.

9.4 For roadbed sub-grade separation, correct geotextile failures, as evidenced by soil pumping or roadbed distortion, by removing any covering material in the affected area and placing a geotextile patch on the exposed geotextile. Cover the patch with the specified cover material and compact before proceeding.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Geosynthetics Sectional Committee, TX 30

Organization	*Representative(s)*
The Bombay Textile Research Association, Mumbai	Dr A. N. Desai (***Chairman***) Shri V. K. Patil (*Alternate*)
Business Coordination House, New Delhi	Shri Samir Gupta Shrimati Ritika Gupta (*Alternate*)
Central Road Research Institute, New Delhi	Shri Sudhir Mathur Shri Jai Bahagwan (*Alternate*)
Central Soil and Materials Research Station, New Delhi	Shri Nripendra Kumar Shri Manish Gupta (*Alternate*)
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Coir Board, Kochi	Dr U. S. Sarma Shri M. Kumaraswamy Pillay (*Alternate*)
Department of Jute and Fibre Technology, Kolkatta	Dr Swapan Ghosh Shri K. R. Gupta (*Alternate*)
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Gujarat Engineering Research Institute, Vadodara	Shri L. V. Ashara Research Officer (*Alternate)*
Indian Jute Industries' Research Association, Kolkata	Shri P. K. Choudhury Shri Koushik Das (*Alternate*)
Indian Jute Manufacturer Association, Kolkatta	Representative
Jaya Shree Textiles, Hooghly	Shri Pawan Sharma
Kusumgar Corporates, Mumbai	Shri Y. K. Kusumgar Dr M. K. Talukdar (*Alternate*)
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Supreme Nonwovens Pvt Ltd, Hyderabad	Shri C. K. Chaudhuri Shri C. K. Jain (*Alternate*)
Techfab India, Mumbai	Shri Anant Kanoi Dr Saurabh Vyas (*Alternate*)
The Synthetics & Art Silk Mills Research Association, Mumbai	Dr Manisha Mathur Shrimati Ashwini Sudam (*Alternate*)

Organization	*Representative(s)*
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BIS Directorate General	SHRI PRABHAKAR RAI, Scientist 'E' and Head (TXD) [Representing Director General (*Ex-officio*)]

Member Secretary
SHRI J. K. GUPTA
Scientist 'C' (TXD), BIS

(*Continued from second cover*)

Survivability is defined as resistance to mechanical damage during road construction and initial operation. The ability of a geosynthetic to survive installation and reasonable service loads shall be assured if it is to perform as designed. Installation damage to a geotextile is a function of the following:

a) Geotextile thickness,
b) Compactive effort and lift thickness,
c) Type and weight of construction equipment used for fill spreading,
d) Grain size distribution of backfill,
e) Angularity of backfill,
f) Polymer used in the manufacture of geotextile, and
g) Geotextile manufacturing process.

Geotexiles normally used for drainage application are mainly made from polyester (PET) or polypropylene (PP). PP is lighter than water, strong and very durable. PET is heavier than water, has excellent strength and creep properties, and is compatible with most common soil environments. Geotextiles are mainly of two types, namely, woven and non-woven geotextiles. Knitted and stitch bonded geotextiles are occaisionally used in the manufacture of speciality products. Non-woven geotextiles are highly desirable for subsurface drainage and erosion control applications as well as for road stabilization over wet moisture sensitive soils. Out of woven geotextiles, slit film fabrics geotextiles are commonly used for sediment control, that is silt fence and road stabilization applications but are poor choices for subsurface drainage and erosion control applications. Monofilament woven geotextiles have better permeability making them suitable for certain drainage and erosion control applications. High strength multifilament woven geotextiles are primarily used in reinforcement applications.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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